

Listing of Claims:

This listing of claims replaces all prior versions and listings of claims in the application.

1. (withdrawn): A method of manufacturing a semiconductor device, comprising the steps of:

(a) forming a first insulating film above a semiconductor substrate formed with semiconductor elements;

(b) forming a contact hole through the first insulating film;

(c) forming a plug made of conductive material capable of being nitrided, the plug being embedded in the contact hole;

(d) forming a nitride etch layer by chemical vapor deposition including heating the semiconductor substrate and supplying nitride source gas to the semiconductor substrate, thereby nitriding the plug from a surface thereof; and forming a nitride layer on the first insulating film covering the nitrided plug surface; and

(e) forming a second insulating film on said etch stopper layer,

wherein said etch stopper layer has a function of stopping etching of said second insulating film.

2. (withdrawn): A method of manufacturing a semiconductor device according to claim 1, wherein the conductive material is W.

3. (withdrawn): A method of manufacturing a semiconductor device according to claim 2, wherein said step (d) is executed at a temperature range of 600 °C to 850 °C in an atmosphere containing ammonia.

4. (canceled)

5. (withdrawn): A method of manufacturing a semiconductor device according to claim 1, wherein said step (d) includes a step of heating the semiconductor substrate and supplying SiN source gas to the semiconductor substrate to form an SiN layer on the first insulating film through chemical vapor deposition, the SiN layer covering the plug.

6. (withdrawn): A method of manufacturing a semiconductor device according to claim 1, further comprising the steps of:

(f) forming a second insulating film on the SiN layer;

(g) forming an opening through the second insulating film, the opening reaching the surface of the plug; and

(h) forming a rare metal layer in the opening, first through physical vapor deposition not using oxygen and then through chemical vapor deposition using oxygen.

7. (withdrawn): A semiconductor device comprising:

a semiconductor substrate formed with semiconductor elements;

an inter-level insulating film formed above said semiconductor substrate; and

a WN plug passing through the insulating film, a nitrogen concentration of said WN plug lowering from a surface of said WN plug toward a deeper position.

8. (withdrawn): A method of manufacturing a semiconductor device, comprising the steps of:

(a) forming a cup-shaped lower electrode above a semiconductor substrate formed with semiconductor elements, the lower electrode having a top surface and side surfaces;

(b) forming a dielectric film on a surface of the lower electrode, the dielectric film in a region near a boundary between the top surface and each of the side surfaces being thicker than the dielectric film in a lower region of the side surfaces; and

(c) forming an upper electrode on the dielectric film,
wherein the lower electrode has a cylinder shape with an inner and an outer side surface, and the dielectric film extends from the inner side surface of the cylinder via the top surface to the outer side surface of the cylinder.

9. (canceled)

10. (withdrawn): A method of manufacturing a semiconductor device according to claim 8, wherein said step (b) includes a combination of a step of forming a film with a good step coverage and a step of forming a film with a poor step coverage.

11. (withdrawn): A method of manufacturing a semiconductor device according to claim 10, wherein said step of forming a film with a poor step coverage is executed by physical vapor deposition, surface reaction limited chemical vapor deposition, low pressure chemical vapor deposition at a pressure of about 1 Torr or higher, or a combination thereof.

12. (withdrawn): A method of manufacturing a semiconductor device according to claim 8, wherein the lower electrode is made of rare metal, and said step (a) forms the lower electrode on an underlie surface exposing a plug made of material capable of being oxidized, and includes a step of forming a film under a condition not using oxygen and a step of forming a film under a condition using oxygen.

13. (withdrawn): A method of manufacturing a semiconductor device according to claim 8, wherein said step (c) includes a step of depositing a lower part of the upper electrode made of rare metal through chemical vapor deposition under a condition containing oxygen at a first concentration and a step of depositing an upper part of the upper electrode made of rare metal through chemical vapor deposition under a condition containing oxygen at a concentration lower than the first concentration.

14. (withdrawn): A semiconductor device comprising:
a semiconductor substrate formed with semiconductor elements;
a lower electrode disposed above a surface of said semiconductor substrate and having a top surface and side surfaces;
a dielectric film formed on a surface of said lower electrode, said dielectric film being relatively thick in a region near a boundary between the top surface and each of said side surfaces and relatively thin and generally uniform in a lower region of each of the side surfaces;
and
an upper electrode formed on said dielectric film.

15. (currently amended): A method of manufacturing a semiconductor device, comprising the steps of:

(a) forming a rare metal layer above a semiconductor substrate formed with semiconductor elements and a lower electrode and an oxide dielectric film of a capacitor;

(b) forming a metal nitride layer ~~on~~ in direct contact with the rare metal layer without using hydrogen-containing gas;

(c) forming an insulating mask layer on the metal nitride layer;

- (d) patterning the insulating mask layer by using a resist pattern;
 - (e) removing the resist pattern used in said step (d);
 - (f) patterning the metal nitride layer by using the patterned insulating mask layer;
 - (g) patterning the rare metal layer by using the patterned insulating mask layer and the patterned metal nitride layer, to constitute an upper electrode of the capacitor; and
 - (h) forming an insulating film over the semiconductor substrate to cover the patterned insulating mask layer, the insulating film being a TEOS based SiO layer,
- wherein said step (d) is terminated before the rare metal layer is exposed.

16. (original): A method of manufacturing a semiconductor device according to claim 15, wherein the insulating mask layer is made of at least one of TaO, alumina, NbO, TiO, and SiO.

17 – 18. (canceled)

19. (original): A method of manufacturing a semiconductor device according to claim 15, further comprising the step of:

- (i) annealing the semiconductor substrate in hydrogen-containing gas.

20. (Canceled)

21. (withdrawn): A semiconductor device comprising:

- a semiconductor substrate with semiconductor elements;
- a rare metal layer disposed above said semiconductor substrate; and
- a TaO film disposed on said rare metal layer, said TaO layer having a same plan shape as said rare metal layer.

22. (withdrawn): A method of manufacturing a semiconductor device, comprising the steps of:

(a) forming a first insulating film above a semiconductor substrate formed with semiconductor elements;

(b) forming a contact hole through the first insulating film;

(c) forming a plug made of conductive material capable of being nitrided, the plug being embedded in the contact hole;

(d) heating the semiconductor substrate in a nitriding atmosphere to nitride the plug from a surface thereof;

(e) forming an etch stopper layer on the first insulating film, the etch stopper layer covering the plug; and

(f) forming a second insulating film on said etch stopper layer,
wherein said etch stopper layer has a function of stopping etching of said second insulating film,
and

wherein said etch stopper layer is made of at least one of TaO, NbO, TiO and alumina.

23. (withdrawn): A method of manufacturing a semiconductor device according to claim 6, further comprising the steps of:

(i) forming an oxide dielectric layer on the rare metal layer; and

(j) forming an opposing electrode on the oxide dielectric layer.

24. (withdrawn): A method of manufacturing a semiconductor device according to claim 8, wherein said dielectric film in said region is about 60% or more thicker than that in said lower region.

25. (currently amended): A method of manufacturing a semiconductor device, comprising the steps of:

(a) forming a rare metal layer above a semiconductor substrate formed with semiconductor elements and a lower electrode and an oxide dielectric film of a capacitor;

(b) forming an insulating mask layer ~~on~~ in direct contact with the rare metal layer;

(c) patterning the insulating mask layer by using a resist pattern;

(d) patterning the rare metal layer by using the patterned insulating mask layer to constitute an upper electrode of the capacitor; and

(f) forming an insulating film over the semiconductor substrate, the insulating film covering the patterned insulating mask layer,

wherein said insulating mask layer is a TaO layer and said insulating film is a TEOS based SiO layer.

26. (canceled)

27. (original): A method of manufacturing a semiconductor device according to claim 25, wherein said resist pattern used in step (c) is removed before step (d).

28. (canceled)

29. (previously presented): A method of manufacturing a semiconductor device, comprising the steps of:

(a) forming a rare metal layer above a semiconductor substrate formed with semiconductor elements;

(b) forming a metal nitride layer on the rare metal layer without using hydrogen-containing gas;

(c) forming an insulating mask layer on the metal nitride layer, the insulating mask layer being a stack of insulating layers;

(d) patterning the insulating mask layer by using a resist pattern;

(e) removing the resist pattern after said step (d);

(f) patterning the metal nitride layer by using the patterned insulating mask layer;

(g) patterning the rare metal layer by using the patterned insulating mask layer and the patterned metal nitride layer;

(h) forming an insulating film over the semiconductor substrate, the insulating film covering the patterned insulating mask layer.

30. (original): A method of manufacturing a semiconductor device according to claim 29, wherein said step (c) forms the insulating mask layer from two of TaO, alumina, NbO, TiO, and TEOS based SiO.

31. (original): A method of manufacturing a semiconductor device according to claim 29, wherein said step (c) forms a stack of TaO, and TEOS based SiO.

32. (original): A method of manufacturing a semiconductor device according to claim 29, wherein said step (c) forms a stack of a layer of alumina, NbO, or TiO, and layer of TEOS based SiO.